An Experimental Comparative Study between Water based Acrylic Polymer Curing Compound and Conventional Curing Procedure for High Strength Concrete

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Abstract— Concrete is an essential building material which is widely used in construction industry all over the world due to its compressive strength. Curing of concrete plays a vital role in durability and other performance necessities. Improper curing can affect the performance and durability easily. Conditions where scarcity of water prevails, and accessibility of structure for external curing becomes difficult, it becomes essential to seek for alternative means of curing. This work thrust for an alternative procedure of curing by using external curing compound. Concrete curing compound consist essentially of waxes, natural and synthetic resins, and solvents of high volatility at atmospheric temperatures. The compound forms a moisture retentive film shortly after being applied on fresh concrete surface. White or gray pigments are often incorporated to provide heat reflection and to make the compound visible on the structure for inspection. The research work consist of i) Development of high strength concrete using OPC53 grade cement and locally available coarse aggregate and fine aggregate and using super plasticizer as admixture. ii) Casting of concrete samples and adopting different curing methods as wet pond curing, in air dry curing, alternative dry and wet curing and using curing compound. iii) Casted samples were tested for flexural strength, shear strength iv) Results of tested samples were tabulate and discussed over the result of achieving the strength in 3, 7, 28 days by different curing methods.

Key words: Curing Compound, Curing Methods, High Strength Concrete, Flexural Strength, Shear Strength, Masterglenium SKY 8566, And Master Kure 185

I. INTRODUCTION

Concrete is an extremely solid, adaptable and mouldable material which is most broadly utilized everywhere throughout the world because of its great compressive strength. On an average around four tons of concrete is produced per individual every year. Concrete is a mixture of cement as a binding material, fine and coarse aggregates, water is used for hydration of cement. Distinctive sorts of admixtures are utilized to enhance the concrete properties.

Today high strength concrete is used in mega projects where loading criteria are more on the structural members. More than M40 grade is touted as high strength concrete. Production of high strength concrete need different type of admixtures such as mineral or chemical admixtures. Concrete having strength up to M70 can be produced by using normal conventional material keeping the w/c ratio less and for workability superplasticizer can be used. Production of high strength concrete should ensure good bond strength between cement paste and aggregates. Quality of materials and strength of aggregates varies the ultimate required compressive strength.

A. Introduction to Curing

Curing of concrete plays an essential role particularly in achieving strength, sturdiness & different performances. Irregular curing can have an effect on mainly strength, durability & different performances. Today various techniques of curing is adopted in construction relying on requirement. As water is a sporadic material today, there is a pressing need to save the water in production enterprise. Water is especially used in making concrete and its usage is extra in the curing procedure. So the exceptional techniques of curing is very important from the point of saving water. Every 1cum of concrete require 3cum of water in construction, maximum of that's used for curing. While areas like scarcity of water, structures isn't always access by humans, external curing cannot be execute. So non-obligatory techniques are can be through internal curing or use of numerous curing compounds. Curing the concrete reduce the chances of concrete scaling, surface dusting, concrete cracking and allows to improve the strength and abrasion resistance. Now a day, many researches are happening approximately the extraordinary sorts of curing and other strategies to improve the concrete sturdiness and other strength parameters.

Curing encourage the hydration of the cement, it consists control on temperature and moisture motion inside the concrete. Curing lets in non-stop hydration of cement and consequently non-stop strength gaining, as soon as curing stops strength gaining of the concrete also stops. Due to early drying of the concrete micro-cracks or shrinkage cracks could develop on surface of the concrete.

B. Significance of the research

Curing the concrete may be a method of maintaining the right moisture conditions to incite cement hydration right away once putting concrete. Maintaining the right moisture conditions are essential as a result of water is important for the hydration method of cementitious materials. Insufficient water within the concrete combine won't proceed the hydration process that ensuing that concrete might not be achieving the fascinating strength and alternative properties. An adequate set is important for concrete to get the specified structural and sturdy properties. Thus set is one among the foremost vital demand for optimum concrete performance in any setting.

Curing ways and hardening period considerably have an effect on hardening potency. Current standards and specifications fail to point an optimum curing system for every application. Consequently, several ways are used by trial and error to assist stop evaporation and supply an honest cure, as well as covering the freshly placed concrete with water, or fabric. What is more, application of liquid

membranous curing compounds has been wide used for concrete pavements. However, restricted analysis has been done to investigate the effectiveness of the numerous activity techniques and their application technologies. What's a lot of, no reliable traditional testing technique is obtainable to gauge the effectiveness of hardening at the world.

II. EXPERIMENTAL INVESTIGATIONS

A. Material used

The different types of material used in this investigation are as follows,

1) Cement

In this investigation 53grade normal Portland cement (OPC) with brand Bharathi cement was used for all concrete mixes. The testing of cement was done as per IS: 12269-1987.

Sl. No.	Characteristics	Values obtained	Standard value
1	Normal consistency	33%.	-
2	Initial setting time (minutes)	48 min	Not less than 30
3	Final setting time (minutes)	240 min	Not greater than 600
4	Fineness (%)	3.5%	<10
5	Specific gravity	3.03	2-6
6	Compression strength (Mpa)		
	3 Days	27.6	20 Mpa
	7 Days	41.5	30 Mpa
	28 Days	58.6	pa

Table 1: Physical properties of cement

2) Chemical Admixture

High-performance super plasticizer, based on PCE (polycarboxylic ether) for concrete MasterGlenium SKY 8566 is a chemical admixture of a new generation based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. MasterGlenium SKY 8566 is free of chloride & low alkali. It is compatible with all types of cements.

Performance Test Data

- Aspect: Reddish brown liquid
- Relative Density: 1.10± 0.02 at 25°C
- pH: > 6 at 25°C
- Chloride ion content: < 0.2%

3) Fine Aggregate

Locally available sand was used as fine aggregate. Sand used was having fineness modulus 2.507 and conformed to grading zone-III as per IS: 383-1970 specification.

Sl. No	characteristics	Values
1.	Type	Uncrushed (natural) (River sand)
2.	Specific gravity	2.53
3.	Moisture content	0.19%
4.	Water absorption	2.1%
5.	Bulking of sand	26.64%
5.	Fineness modulus	3.13
6.	Grading zone	III

Table 2: Physical properties of sand

4) Coarse Aggregate

The crushed stone combination were collected from the native quarry. Coarse aggregates employed in the experimentation were 20mm and 10mm down size and tested as per IS: 2386-1963 specifications.

Sl. No	Characteristics	Value
1.	Type	Crushed
2.	Maximum size	20mm
3.	Fineness modulus	7.68
4.	Specific gravity	3.06
5.	Moisture content	0.7%
6.	Water absorption	2.7%
7.	Crushing value	21.2%
8.	Impact value	35.2%

Table 3: Physical properties of coarse aggregate

5) Water

Ordinary potable water free from organic content, turbidness and salts; was used for mixture and for curing throughout the investigation.

6) Curing Compound

Master Kure 185 is a non-degrading, membrane forming liquid based on specially formulated acrylic polymer for curing newly placed or freshly de-shuttered concrete; assists in the retention of water during hydration. The resultant film retains sufficient moisture in the concrete to ensure full hydration of the cement; essential for optimum strength development.

Performance test data (ASTM E1347)

- Dry film appearance: white / Clear
- Loss of Water (ASTM C156):< 0.55 kg /m2
- Drying time (ASTM C309): Less than 3 Hours
- Appearance: Clear / White liquid
- Specific gravity Clear: 1.04 ± 0.02 @ 25º C.
- Specific gravity White: 1.07 ± 0.02 @ 25 o C.
- Day light reflectance :> 60%.

B. Mix design for M50 grade of concrete as per (IS 10262-2009)

1) Design Stipulations

- Grade designation: M50.
- Type of cement: OPC 53 Grade
- Maximum size of aggregate: 20 mm
- Type of aggregate: Crushed angular
- Degree of supervision: Good
- Type of exposure: Mild.
- Maximum cement content: 450 kg/$m^{3.}$
- Workability: 125mm (slump).
- Method of concrete placing: Manually.
- Chemical admixture type: Superplasticizer.
- Test data for material
  1) Cement
  - Specific gravity: 3.03
  2) Fine aggregate:
  - Gradation: confirming to zone-III
  - Specific gravity: 2.53.
  3) Coarse aggregate:
  - Gradation: uniformly graded
  - Specific gravity: 3.06.
  4) Chemical Admixture:
  - Superplasticizer.

– Specific gravity: 1.10.
– Mix proportion
1) Cement = 450 Kg/m^3
2) Water = 142 Kg/m^3
3) Fine aggregate = 640 Kg/m^3
4) Coarse aggregate = 1400 Kg/m^3
5) W/C ratio = 0.28
6) Chemical admixture = 4.5 Kg/m^3

Proportions of ingredients are as follows

CEMENT	F.A	C.A	ADM.	W/C
1	1.42	3.11	0.01	0.28

Table 4: Mix proportion

C. Casting of Concrete Specimens

The concrete ingredients particularly cement, fine mixture (sand) and coarse mixture were weighed in step with their proportion and that they were dry mixed on non- absorbent platform. Supported the water cement quantitative relation the standard of water is adscititious. For workability superplasticizer were used. When even admixture of concrete it absolutely was poured into the concrete moulds, all concrete moulds were clean from the present concrete stain and oil was applied within the moulds.

The fresh concrete was placed into the moulds with the assistance of scoop. The moulds were crammed with concrete in 3 layers every being compacted by normal tamping rod totally associate degreed vibrated victimization. Table vibrator is used to attain an adequate compaction. After 24 hours, the specimens were demoulded and transferred to numerous action ways. All the specimens were cured for 3, 7 and 28 days. When completion of 3, 7 and 28 days of action, they were tested for compaction and tensile strength test.

D. Curing Procedure

1) Pond curing

In this method specimens are immersed in water for a period of 3, 7 and 28 days in a pond.

2) Dry curing

In this method specimens are kept in open area after demoulding. No water is used for curing. Specimens are in actual environmental conditions.

3) Alternative wet and dry curing

In this method specimens are kept in actual environment condition and alternatively morning and evening two times in a day water is sprayed.

4) Curing by curing compound

After demoulding of specimens, concrete surface is cleaned by water removing oil strains and any foreign matters. Then concrete surface is applied by curing compound by means of spraying or by brush. Evenly concrete surface is applied by curing compound and kept in natural environmental conditions.

III. TESTING OF CONCRETE SPECIMENS

A. Flexural Strength Test

Flexural strength of a concrete is a measure of its ability to resist bending. Flexural strength can be expressed can be expressed in terms of 'modulus of rupture'. Concrete specimens for flexural strength were in dimensions 100x100x500 mm. The specimen is subjected to bending, using single point loading until it fails. The effective span (L) is 400 mm. The test procedure was carried out in accordance with IS: 516-1959 specification. The flexural strength of the specimen shall be expressed as the modulus of rupture and shall be calculated to the nearest 0.05MPa using the following formula:

$$F = 3PL/ 2(bd^2)$$

F = Flexural strength of concrete (in MPa)
P = Maximum load applied to the specimen
L = Effective span of the specimen
B = Width of the specimen
D = Depth of the specimen

B. Shear Strength Test

An L- shaped shear test specimens were prepared as proposed by Bairagiet from 150 mm cubes by inserting a wooden block 90x60 mm in cross section and 150mm high in to the cube moulds before casting of concrete. These specimens were tested on universal testing machine. A loading arrangement was made such that a direct shearing force was applied on the shorter arm of the 'L' shaped specimen (i.e. over an area of 150x60 mm). The maximum applied load (P) was noted down.

The failure load (F) due to the applied shear force is obtained by using the relation

Failure load (F) = PL1/ (L1+L2) (in MPa)

Where, P = Failure load in KN

L1 = 25mm, L2 = 25mm

The shear strength is given by the relation Shear strength = F/A

Where, F = Failure load, A = Area on which shear force is applied = 150mm X 60mm.

Fig. 1: Flexural strength test

Fig. 2: Shear strength test

IV. RESULTS AND DISCUSSION

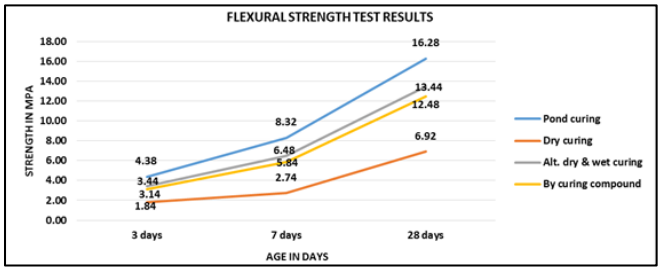

Fig. 3: Flexural strength results

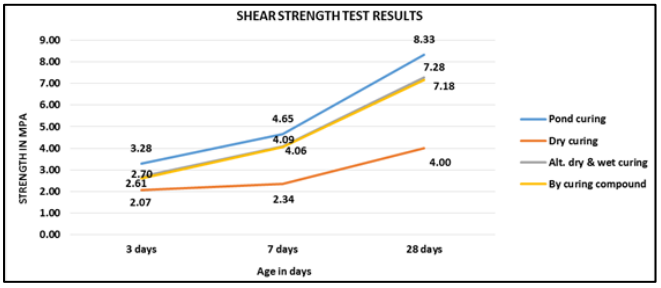

Fig. 4: Shear strength results

A. Flexural strength test results

1) Discussion

- Fig 3 showing the results of average flexural strength at 3,7 & 28 days with various curing methods, it can be observed pond curing method giving the highest flexural strength 16.28 MPa whereas dry curing giving the least strength 6.92 MPa.
- Alternative dry and wet method giving efficiency of 82% of pond curing.
- Curing compound achieving 76% strength of pond curing showing good flexural strength in 28 days.
- Curing compound giving strength near to alternative dry and wet method.

B. Shear strength test results

1) Discussion

- Fig. 4 showing the result of average shear strength at 3,7 & 28 days with various curing methods, it can be observed pond curing method giving the highest shear strength 8.33 MPa whereas dry curing giving the least strength 4.00 MPa.
- Alternative dry and wet method giving efficiency of 87% of pond curing.
- Curing compound achieving 86% strength of pond curing showing good shear strength in 28 days.
- Curing compound giving strength near to alternative dry and wet method.

V. Conclusions

1) As water is scarce material today there is a need of saving water in construction so there is a need of alternative materials in construction to save water. Curing of concrete by means of water needs more amount of water. So use of curing compound may save water and also reducing labour works.
2) By observing 28 days flexural and shear strength of high strength concrete pond curing method gives the highest strength results and most efficient method of curing. But pond curing method is not suitable in-situ for all component of the structure.
3) Dry curing is to be avoided at the development site because designed target strength isn't achieved by this method.
4) Alternative dry and wet method is most commonly adopted method of curing in site. Results shown that; by this method the target strength can be achieved. This curing method giving overall 85% efficiency compare to pond curing. But this method cannot be executed in all type of works.
5) Water based acrylic polymer curing compound shown the overall 83% efficiency compare to pond curing and achieved the target strength in 28 days. It's giving strength nearer to the alternative dry and wet method.
6) The information developed during this study indicate that water is tough and curing compounds effective in larger area like concrete pavement, bridges, dams, flyover etc.

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